

Three-Dimensional Printing of Gradient Meshed SOFC Seal Composites

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OBJECTIVES:

Solid oxide fuel cell (SOFC) holds the greatest promise as a power conversion device. However, current SOFC seals are hindering this very promising power conversion technology, mainly because of a thermal expansion coefficient (TEC) mismatch that results in seal cracking and gas leakage issues. This program aims to solve this challenging problem by innovatively applying a gradient meshed and toughened self-healing SOFC seal concept. Specifically, we will match the TEC of the SOFC seal with that of the other cell components by creating a gradient TEC transition across the thickness of the seal through a shape memory alloy, and provide toughening and self-healing mechanisms for the glass seal matrix if cracking does occur. When the above aspects are combined, the proposed novel composite seal will mitigate the seal cracking and gas leakage issues and enable the long-term operation of the SOFCs.

ACCOMPLISHMENTS:

So far, we have successfully synthesized TiNiHf shape memory alloy through the arc-melting process. We have printed three-dimensional metallic mesh structure of different wire thicknesses. We have also mixed and synthesized SrO-La₂O₃-Al₂O₃-B₂O₃-SiO₂ glass to act as the matrix of the seal. Here, we will present the work accomplished for the fabrication of the shape memory alloy TiNiHf skeleton using the three dimensional printing technique and the process of combining the shape memory alloy skeleton with the most promising SOFC seal glass SrO-La₂O₃-Al₂O₃-B₂O₃-SiO₂.

FUTURE WORK:

In our future work, we will evaluate the new composite seal for the effectiveness of providing gradient TEC, the phase transformation toughening mechanism, and the crack self-healing capability. We will also devise tests to simulate the SOFC seal operation conditions, and identify the optimal composite seal design in providing superior performances by preventing cracking and gas leakage.

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